PATENT SPECIFICATION

DRAWINGS ATTACHED

982,495

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Date of Application and filing Complete Specification May 17, 1963.

No. 19776/63.

Complete Specification Published Feb. 3, 1965.

Index at acceptance:—G5 R(43D1C, 43D1Y, 43D2Y, 43DY, 43Y, 44B3, 44BY, 44C1D1, 44C1DU, 44C1DY, 44C1E, 44C1F, 44C1Y, 44CY, 44Y, 46X5)

Int. Cl.:—G 10 j

COMPLETE SPECIFICATION

Differential Capstan Assembly

We, MINNESOTA MINING AND MANUFACTURING COMPANY, a corporation organised and existing under the laws of the State of Deleware, United States of America, of 2501, Hudson Road, St. Paul, Minnesota, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a tape-feeding mechanism for driving a tape with a portion of the tape under constant tension and traveling at a constant speed along an accurately controlled path. While the mechanism may be used to drive various kinds of tapes it is primarily useful for driving magnetic tapes for recording and reproducing signals corresponding to television programs.

A very large amount of information must be transmitted in each second of television signal recording and reproduction, and to keep the length of a television tape within practical limits, the information must be distributed not only longitudinally of the tape but also transversely of the tape. Even with such compact recording, high rates of travel are necessary. The problem is to provide precise control of the tape with the travel of the tape past a playback transducer exactly duplicating the previous travel of the tape past a recording transducer. Even the most minute fluctuations in the speed of the travel result in distortion of the signals by frequency modulation and the slightest departure of the tape from the predetermined path of travel causes serious signal distortion by phase displacement.

In a typical tape recording and playback system some type of driving mechanism receives the tape under appreciable tension from a pay-out reel, forms the tape into a loop to pass at least one transducing station under predetermined tension and then delivers the tape from the loop to a take-up reel which again places the delivered tape under appreciable tension. Since both of the reels place the tape under tension, irregularities in the travel of the loop of tape past a transducing station commonly originate in the two reels. The problem may be readily appreciated when it is considered that a fully loaded reel is both bulky and heavy and must rotate at a peripheral speed of many feet per second. Very high magnitudes of angular momentum of the two reels are unavoidable and with the greatest precautions, troublesome degrees of eccentricity of the wound tape are inevitable.

Other irregularities in the travel of the tape past a transducing station originate in the tape driving mechanism itself. To place the loop under tension, the ingoing tape must be driven at one speed and the outgoing tape at a slightly higher speed with consequent elongation of the tape that forms the loop. Any fluctuation in the degree to which the tape is elongated results in frequency modulation of the signal. In addition, it is exceedingly difficult to place a portion of the rapidly traveling tape under local tension without creating skewing forces with serious effects on the signals.

According to the present invention there is provided a tape-feeding mechanism comprising an arrangement of guides adapted to form a loop of tape of which ingoing and outgoing runs pass different circumferential portions of a rotatable body of a substantially incompressible but resiliently deformable elastomer and first and second pressure-applying means adapted to press the ingoing and outgoing runs of the tape respectively against the said circumferential portions, the outgoing run with slightly higher pressure than the ingoing run.

By driving both the ingoing tape and outgoing tape with gripping pressure of high magnitude applied to a substantial area of the

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tape slippage is completely avoided and the tape loop is isolated completely from any irregularities originating in either of the two reels. By further providing for the gripping pressure to be uniformly applied across the full width of the tape, the tape is tensioned uniformly across its width to eliminate skewing effects.

The operation of the invention depends upon the capacity for elastic flow of a noncompressible resilient rubber-like material. If a circumferentially moving body of such material of uniform radial cross section is restricted in radial cross section by laterally applied pressure at a point in its rotary travel, the material is locally accelerated by elastic flow through the restriction zone in a manner closely analogous to the acceleration of a liquid stream through a restriction.

The elastic body is under local pressure against the ingoing traveling tape and again against the outgoing traveling tape with pressure of such magnitude and with the pressure zone of such extent longitudinally of the tape as to completely block out effects originating in the two reels. The required differential drive to place the traveling loop of tape under predetermined tension is accomplished simply by creating a slightly higher rate of elastic flow of the elastomer at the outgoing end of the traveling loop.

The invention will now be described in more detail by way of example with reference to the accompanying drawing. The drawing shows a simplified diagrammatic plan view of one embodiment of the invention.

The drawing shows a traveling magnetic tape generally designated T which is unreeled from a conventional pay-out reel (not shown) and makes a 90° turn around a smooth polished guide post 10. The traveling tape makes a 180° turn around a reversing guide roller 12 and again makes a 90° turn around a second polished guide post 14 to be wound upon a conventional take-up reel (not shown).

The tape traveling between the first guide post 10 and the reversing guide roller 12 is pressed against one side of a drive capstan 15 by a nip-roller 16 and the tape returning from the reversing guide roller to the second guide post 14 is held under pressure against the other side of the drive capstan by a second nip-roller 18.

This arrangement forms a portion of the tape into a loop around the reversing guide roller 12 and places this loop portion under tension for recording or playing back signals by suitable transducer means. The drawing shows a recording head 20 in contact with the ingoing leg of the loop and a play-back head 22 in contact with the outgoing leg of the loop.

The capstan 15, which is mounted on a power driven spindle 24, has a solid cylindrical core 25 of rigid material on which is mounted an annular body 26 of a suitable elastomer, this body forming a circumferential portion of the capstan having a circumferential surface 28. The cylindrical elastomer body 26 when unstressed is of uniform radial cross section and has an axial length of at least the width of the tape T and may comprise any suitable rubber-like body which is substantially incompressible but is resiliently deformable under moderate pressure.

The ingoing nip-roller 16 which may be made of metal presses the ingoing tape against the annular elastomer body 26 with sufficient force to ensure that a substantial area of the tape is effectively frictionally engaged to prevent slippage. The required amount of pressure depresses the elastomer body 26 appreciably so that the nip-roller 16 in co-operation with the solid core 25 forms a restriction of less radial dimension that the unrestrained portion of the elastomer body and the elastomer body must contract in radial dimension to pass through the restriction. Since the elastomer is substantially incompressible and a constant volume passes each circumferential point in a unit of time, the elastomer material must pass through the radial restriction by elastic flow with local acceleration of the circumferential speed of the elastomer material. Because of the high coefficient of friction between the tape and the locally compressed elastomer material, the tape conforms with the peripheral speed of the elastomer material at the point of maximum restriction and maximum velocity.

In like manner, the outgoing metal nip-roller 18 presses the outgoing tape against the rotating elastomer body 26 on the other side of the capstan but exerts greater pressure than the ingoing nip-roller 16 and locally depresses the elastomer body to a greater degree to cause the elastomer material to pass through a second restriction of lesser radial dimension than the first restriction. Because of the narrower restriction through which the elastomer must pass by elastic flow, the velocity of the elastomer at the restriction is greater than the velocity of the elastomer at the restriction on the ingoing side of the capstan. Consequently, the outgoing run of the tape loop is pulled by the capstan at a faster rate than the ingoing run with consequent tensioning and elongation of the tape in the loop.

In a typical practice of the invention, the outgoing run of the tape loop at the outgoing nip-roller 18 travels 0.02% faster than the ingoing run of the tape at the ingoing nip-roller 16. This velocity differential is obtained by positioning the outgoing nip-roller 18 at a radial distance from the capstan core 25 that is approximately 0.02% less than the radial distance of the ingoing nip-roller 16 from the capstan core.

Any suitable arrangement may be provided

for mounting the nip-rollers 16 and 18 to co-operate with the capstan 15 in the described manner. Preferably an arrangement is employed which permits the nip-rollers to be retracted from the drive capstan whenever desired but does not require a new adjustment each time the nip-rollers are restored to their pressure-applying positions.

In the arrangement shown in the drawing, each of the two nip-rollers 16 and 18 is journaled on a forked arm 30 of a bell crank 32 that is mounted on a pivot 34. The second arm of the bell crank 32 has a transverse threaded bore 35 at its outer end into which a screw 36 is adjustably threaded. A lock nut 38 is provided to maintain any selected adjustment of the screw in the threaded bore. Each of the screws 36 is connected by a universal joint 45 to the armature 40 of a corresponding solenoid 42.

In the construction shown, each of the screws 36 is pivotally connected by a cross pin 44 with a universal joint link 45. The universal joint link 45 in turn is pivotally connected to a pull rod 46 by a second cross pin 48 that is perpendicular to the first cross pin 44. The pull rod 46 is rigidly connected to the corresponding armature 40 and in effect comprises an axial extension of the armature.

Since each of the armatures 40 is pulled to a given limit position whenever the corresponding solenoid is energized, it is apparent that with a given adjustment of the screw 36 relative to the bell crank 32, the corresponding nip-roller will exert the same pressure against the drive capstan 15 each time the solenoid is energised. Thus once the two screws 36 are adjusted for satisfactory operation with the tape driven differentially on opposite sides of the capstan, the two solenoids may be de-energized and energized repeatedly with no change in the degrees of pressure exerted by the two nip-rollers.

Since the two nip-rollers exert sufficient pressure to cause the traveling tape to conform to the two rates of elastic flow of the elastomer, the loop of tape around the reversing guide roller 12 is completely isolated from any effects on the tape that may be traced to the two reels. The annular elastomer body 26 and the solid core 25 on which it is mounted are accurately dimensioned with precise concentricity to cause the two runs of the tape to pass the drive capstan at constant speeds. The two nip-rollers are not only accurately dimensioned but are also precisely axially parallel with the drive capstan 16 to avoid any possibility of applying skew forces to the traveling tape.

WHAT WE CLAIM IS:—

1. A tape-feeding mechanism comprising an arrangement of guides adapted to form a loop of tape of which ingoing and outgoing runs pass different circumferential portions of a rotatable body of a substantially incompressible but resiliently deformable elastomer and first and second pressure-applying means adapted to press the ingoing and outgoing runs of the tape respectively against the said circumferential portions, the outgoing run with slightly higher pressure than the ingoing run.

2. A tape-feeding mechanism according to claim 1, wherein the said body is of annular form with constant (undeformed) radial thickness and is mounted on a rigid cylindrical core.

3. A tape-feeding mechanism according to claim 1 or 2, wherein the pressure-applying means are nip-rollers whose axes are parallel to the axis of rotation of the rotatable body.

4. A tape-feeding mechanism according to claim 3, wherein the rotatable body and nip-rollers all have an axial extent at least equal to the width of the tape.

5. A tape-feeding mechanism according to claim 3 or 4, comprising means for moving the nip-rollers between their operative positions and positions spaced away from the rotatable body.

6. A tape-feeding mechanism according to claim 5, wherein the means for moving the nip-rollers comprise respective solenoids and mechanical linkages between the solenoids and rollers.

7. A tape-feeding mechanism according to claim 6, wherein the effective operative travels of the linkages are adjustable.

8. A tape-feeding mechanism substantially as hereinbefore described with reference to and as shown diagrammatically in the accompanying drawing.

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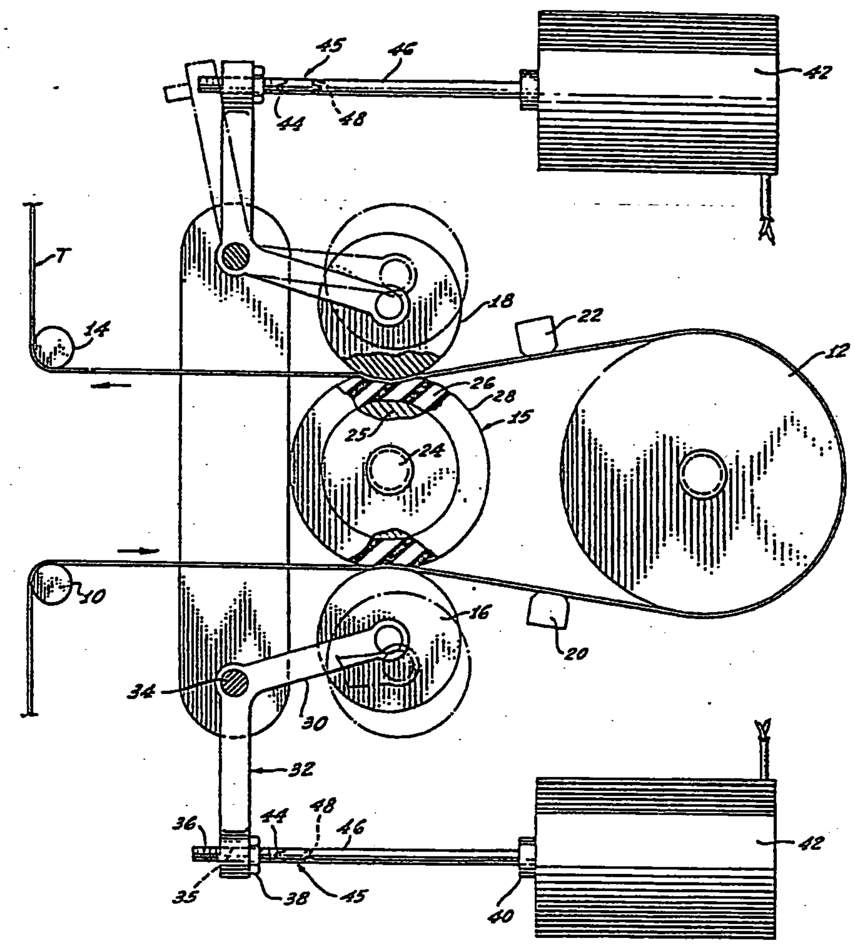
Leamington Spa: Printed for Her Majesty's Stationery Office by the Courier Press.—1965.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.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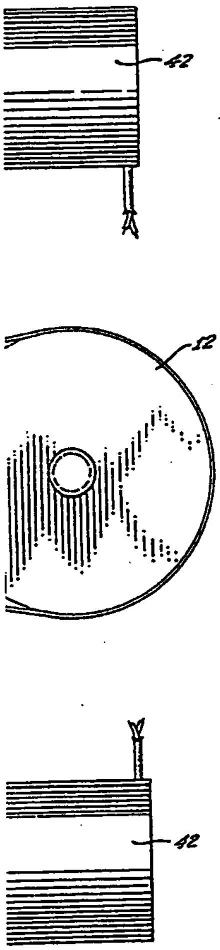

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